# Coastal Cities and Environmental Change[1]

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## Introduction

Environmental historians, spurred on by concerns about overfishing, aquatic ecosystem degradation and marine acidification, are now making major contributions to research on the seas and oceans.[2] Coastal cities are crucial areas of study in opening up this exciting new research frontier, and while a number of themes, such as their roles in trade, empire, migration and communications networks, have already generated a substantial literature, how these cities have shaped – and been shaped by – their environments has to date received far less historical attention.[3]

Over the last twenty years or so, urban environmental historians have been working to reveal the interconnections between the built and the natural world, drawing on a variety of theoretical tools and approaches to demonstrate their complex, two-way relationships.[4] William Cronon's seminal study of Chicago, for example, showed that the nineteenth-century growth of this modern American metropolis placed heavy demands on its ever-widening hinterland. Cronon traced the enormous flows of natural resources like wood, wheat and livestock into Chicago for processing in its sawmills, grain elevators and slaughterhouses, which were then shipped on to urban markets elsewhere. Cronon's history emphasised the interdependence of the city and the countryside, reminding us that they are not separate entities. More recently, Joel Tarr has championed the concept of urban metabolism to better highlight the linkages between the country and the city. Tarr, drawing on the ideas of the sanitary engineer Abel Wolman, has likened modern cities to living organisms, dependent for

[1] This paper is based on my keynote address to the 6th ESEH Conference on 'Encounters of Sea and Land' at Turku, Finland, in 2011.

[2] For recent overviews of the burgeoning field of ocean environmental history see: Michael Chiarappa and Matthew McKenzie, (eds.) 'Marine Forum,' *Environmental History* 18:1 (2013), pp.3-126; Helen M. Rozwadowski, 'The Promise of Ocean History for Environmental History,' *Journal of American History* 100:1 (2013) pp.136-39; and W. Jeffrey Bolster, 'Opportunities in Marine Environmental History,' *Environmental History* 11:3 (2006), pp.567-97. For coastal zones over the long term see: John R. Gillis, *The Human Shore: Seacoasts in History* (Chicago: University of Chicago Press, 2012).

[3] For recent surveys of the literature on these topics see: Craig A. Lockard, '"The Sea Common to All": Maritime Frontiers, Port Cities, and Chinese Traders in the Southeast Asian Age of Commerce, ca. 1400-1750, ' *Journal of World History* 21:2 (2010), pp.219-46; Glen O'Hara, '"The Sea is Swinging Into View": Modern British Maritime History in a Globalised World, ' *English Historical Review* CXXIV:510, (2009), pp.1109-34; Eric Tagliacozzo, 'An Urban Ocean: Notes on the Historical Evolution of Coastal Cities in Greater Southeast Asia,' *Journal of Urban History* 33:6 (2007), pp.911-32; Karen Wigen, 'AHR Forum: Oceans of History,' *The American Historical Review* 111:3 (2006), pp.717-21.

[4] For the evolution of urban environmental history see: Dieter Schott, 'Urban Environmental History: What Lessons are there to be Learnt?' *Boreal Environment Research* 9 (2004), pp.519-28. See also: Christopher Sellers, 'Cities and Suburbs' in Douglas Cazaux Sackman (ed.) *A Companion to American Environmental History* (Malden MA: Wiley-Blackwell, 2010); and Genevieve Massard-Guilbaud and Peter Thorsheim, 'Cities, Environments, and European History', *Journal of Urban History* 33:5 (2007), pp.691-701.

their survival on inputs of clean air and water, fresh food, fossil fuels, and construction materials, as well as the efficient removal of harmful outputs of waste.[5]

The networking of the modern city began in the mid-nineteenth century, with the construction of underground water supply and sewerage systems. Martin Melosi has studied the impacts of a variety of technologies and infrastructures on the growth of cities, particularly waste management systems that often locked urban centres into inefficient and polluting methods of disposal – interpreted as 'path dependence'. The choices made in adopting technologies and building large-scale infrastructures, Melosi has argued, 'clearly constrained future options' mainly because 'the existing infrastructure was too extensive, too costly to replace, or resistant to change'.[6] Coastal cities, many with large-scale fixed systems of sanitation and protected by hard-engineered sea defences, tend to be highly path-dependent places.

However, to date there are few book-length historical studies that examine cities and their relationships with the sea from an environmental perspective.[7] And if cities have long been viewed as separate from nature, the sea itself - because of its apparently unchanging and timeless character - as Jeffrey Bolster has recently observed, was 'long imagined as distinct' from other places; existing both 'outside of history' and 'beyond the pale' of historians' concerns. In considering why the seas and oceans have been under-researched by historians, he points out that part of the problem is that, unlike changes in the land, changes in the marine environment are much less visible: on the surface, the seas and oceans appear 'forever unchanged'.[8] If urban environmental historians are finally beginning to break down one of modernity's most durable dualisms, the separation of the country and the city, there is still a good deal of work to be done with regard to reconciling cities and the sea.

Paying more attention to coastal cities makes sense because, as the NASA image below of the earth at night helps to illustrate (Figure 1), the highest share of urban

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[5] Joel A. Tarr, 'The Metabolism of the Industrial City,' *Journal of Urban History* 28:5 (2002), pp.511-45. See also: Martin V. Melosi, 'Humans, Cities, and Nature: How Do Cities Fit in the Material World?,' *Journal of Urban History* 36:1 (2010), pp.3-21.

[6] Martin V. Melosi, 'Path Dependence and Urban History: Is a Marriage Possible,' in Dieter Schott, Bill Luckin and Genevieve Massard-Guilbaud (eds.) *Resources of the City: Contributions to an Environmental History of Modern Europe* (Aldershot: Ashgate, 2005), p.274. See also: *idem*, *The Sanitary City: Urban Infrastructure in America from Colonial Times to the Present* (Baltimore MD: Johns Hopkins University Press, 2000).

[7] Although this situation is slowly beginning to change, particularly for the United States, see: Michael Rawson, *Eden on The Charles: The Making of Boston* (Cambridge, Mass: Harvard University Press, 2010); Fred Feddes, *A Millennium of Amsterdam* (Bussum: Thoth, 2012); Anthony N. Penna and Conrad Edick Wright (eds.), *Remaking Boston: An Environmental History of the City and its Surroundings* (Pittsburgh: University of Pittsburgh Press, 2009); Connie Chiang, *Shaping the Shoreline: Fisheries and Tourism on the Monterey Coast* (Seattle: Washington University Press, 2008); Matthew Klingle, *Emerald City: An Environmental History of Seattle* (New Haven & London: Yale University Press, 2007); Craig E. Colten, *An Unnatural Metropolis: Wresting New Orleans from Nature* (Baton Rouge LA: Louisiana State University Press, 2005).

[8] See: W. Jeffrey Bolster, 'Putting the Ocean in Atlantic History: Maritime Communities and Marine Ecology in the Northwest Atlantic, 1500-1800,' *The American Historical Review* 113:1 (2008), pp.19-47; and *idem*, 'Opportunities in Marine Environmental History,' p.577.

dwellers worldwide lives on or near to the coast. Over half of the world's 7 billion-plus population now lives in urban areas: a proportion that is set to increase to around 60 per cent by 2030, with the most rapid urban growth taking place in the coastal cities of the developing world, especially in China. Given the high concentration of populations and economic activities in (mainly coastal) cities, they consume vast amounts of resources. The world's cities are, as a recent report for the United Nations Human Settlement Programme (UN-HABITAT) noted, the 'front lines in the battle for sustainability'. At the same time, coastal ecosystems around the world have been identified by a number of scientific studies as being under ever-increasing threat from overexploitation and mismanagement by coastal communities.[9]

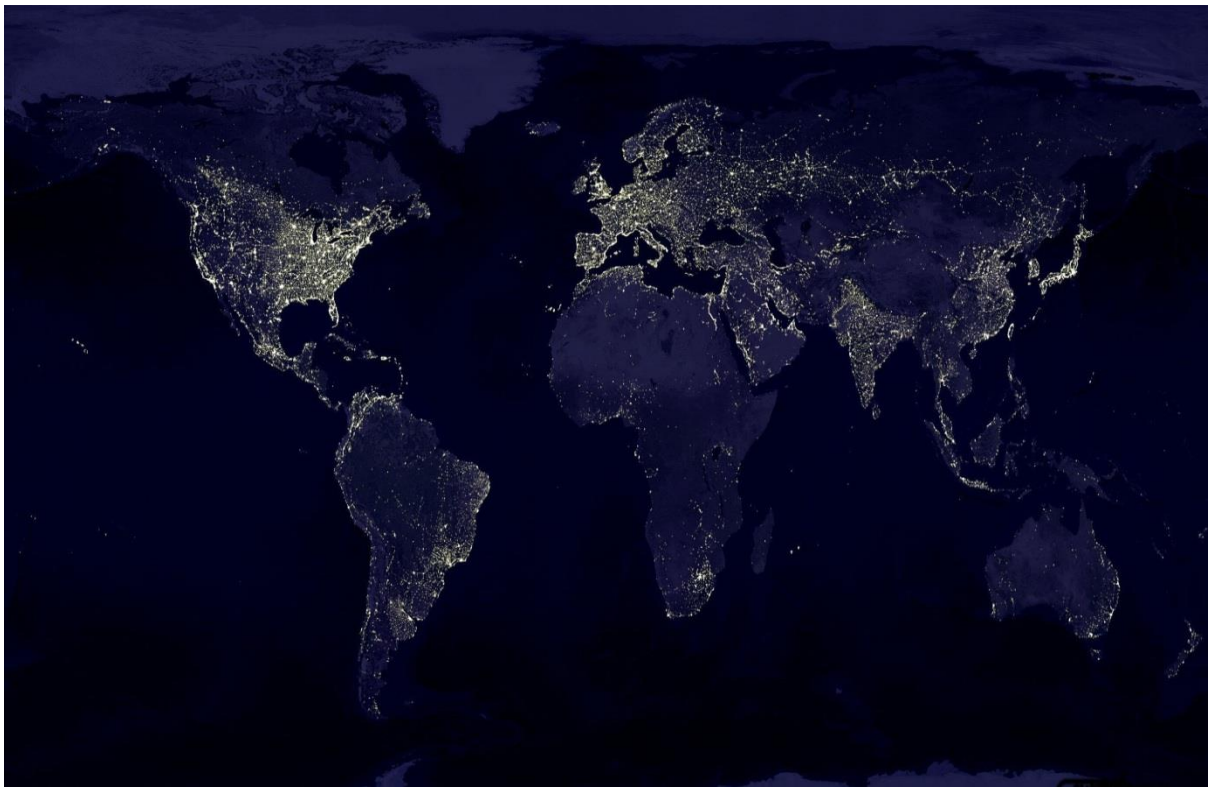

Figure 1: The Earth at Night.
Source: Reproduced Courtesy of NASA.

But coastal cities are not only in the vanguard of 'the battle for sustainability', they are also in the front lines in relation to the impacts of climate change, increasingly at risk from sea level rise and extreme weather events, especially the residents of the

[9] UN-HABITAT, *State of the World's Cities 2006/7: The Millennium Development Goals and Urban Sustainability* (London: Earthscan, 2007), p.128; for example, Rashid Hassan, Robert Scholes and Neville Ash (eds.), *Millennium Ecosystem Assessment, Volume 1: Ecosystems and Human Well-Being – Current State and Trends* (Washington DC: Island Press, 2005), chapter 19.

poorest areas, in both the developed and developing world.[10] As urban centres have become the main battle-grounds where sustainability and climate change are concerned, the need for a historically informed understanding of the interconnections between cities and their environments – and especially between cities and the sea – has become increasingly urgent.

The coastal environment is a dynamic one, and coastal cities are, of course, as diverse as the ecosystems of which they are a part, encompassing commercial, manufacturing, military, and transport activity, as well as a range of leisure functions. In addition, the fortunes of individual cities have waxed and waned over time. Therefore, this paper will focus on some common themes and issues with regard to their roles as key drivers of environmental change, particularly where the shoreline meets the sea. With sections on 'trade and exchange', 'industry and metabolism', 'resorts and environment', and 'coastal cities and natural disasters', it will highlight some innovative research – both old and new – in this area of study, as well as offer some suggestions for further inquiry in the conclusion.

## Trade and exchange

Coastal cities have long been gateways or hubs for international trade and exchange, facilitating flows of capital, resources and biota. In the early-modern era, for example, Europe's leading port cities, such as Amsterdam, Genoa, Lisbon, London, Seville and Venice, competed with each other to become the dominant centres of international trade networks.[11] Although China and India were the world's most productive economies up until the end of the eighteenth century, merchants in these European cities were in the vanguard of a commercial capitalism that created a truly global economy, incorporating the Americas for the first time. Iberian commercial ambition – the search for a new trade route to Asia – also initiated what Alfred Crosby called the 'Columbian exchange'. Following Columbus's 1492 voyage, the previously isolated ecosystems of the Old and New Worlds were brought together as never before, and the world became a place without 'biological borders.' One important function of bustling seaports, both large and small, was as exit and entry points for European migrants and, to use Crosby's much-quoted phrase, the 'grunting, lowing, neighing, crowing, chirping, snarling, buzzing, self-replicating and world-altering avalanche' of organisms that accompanied them.[12]

Since Crosby's early analyses, histories of biological transfers have become less Eurocentric, for example, by stressing the importance of the earlier Monsoon

[10] UN-HABITAT, *Cities and Climate Change: Global Report on Human Settlements 2011* (London: Earthscan, 2011).
[11] Stephen Mosley, *The Environment in World History* (London & New York: Routledge, 2010), chapter 5.
[12] Alfred W. Crosby, *Ecological Imperialism: The Biological Expansion of Europe, 900-1900*, New Edition (New York: Cambridge University Press, 2004), p.194; *idem*, *The Columbian Exchange: Biological and Cultural Consequences of 1492*, 30th Anniversary Edition (Westport: Greenwood Press, 2003).

exchange across the Indian Ocean world, connected by ports such as Mombasa in East Africa, Ormuz in the Persian Gulf, and Calicut in western India.[13] Nonetheless, after 1492 plant and animal transfers profoundly reshaped the face of the earth, as economically important crops for food and fibre spread around the world. The creation of 'transported landscapes', to borrow Edgar Anderson's term, also saw the construction of new coastal cities from scratch: both as gateways for steadily increasing biological traffic, and as hubs for an emerging global market economy, through which the natural goods extracted by Europe's seaborne empires flowed. For example, great ports in the Americas such as Havana (1515, Spanish), New York (1625, Dutch, originally New Amsterdam), Boston (1630, English), and Montreal (1642, French) all had their origins in the Atlantic trade in sugar, tobacco, timber and furs.[14]

While most introductions were intentional, such as plantation-grown sugar, undertaken by merchants and settlers to boost the flow of profitable commodities to metropolitan markets, some were unintentional, such as the long-distance spread of infectious agents into new populations. As conduits for large numbers of people, new seaports were also gateways for infectious 'crowd' diseases. Old World infections, most notably smallpox, measles and influenza, spread from such 'seeding points' to decimate indigenous populations who lacked immunity in the New ('virgin population' epidemics saw mortality rates of up to 90 per cent among Amerindian peoples). Syphilis is thought to have arrived in Europe from the Americas following the unification of disease pools (although the origins of the disease are still contested), but this did not significantly raise European mortality rates.[15] As trade and mobility intensified, ports and harbours were the destinations for other marine stowaways too, such as zebra mussels (*Driessena polymorpha*), comb jellyfish (*Mnemiopsis leidyi*), and the Asian clam (*Potamocorbula amurensis*), particularly via discharges of ships' ballast water. Estuarine ecosystems are perhaps 'the most invaded' in the world by nonindigenous species with, for example, some 210 aquatic 'bioinvaders' – including the Asian Clam – now established in San Francisco Bay, California, (accelerating to a rate of one new species every 14 weeks between 1961-95), causing significant ecological changes.[16]

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[13] For example, see: John R. McNeill, 'Europe's Place in the Global History of Biological Exchange,' *Landscape Research* 28:1 (2003), pp.33-39; Haripriya Rangan, Judith Carney and Tim Denham, 'Environmental History of Botanical Exchanges in the Indian Ocean World,' *Environment and History* 18:3 (2012) pp.311-42.

[14] Edgar Anderson, *Plants, Man and Life*, (Berkeley and Los Angeles: University of California Press, 1952), chapter 1; John Rennie Short, *The Urban Order* (Oxford: Blackwell, 1996).

[15] Tony McMichael, *Human Frontiers, Environments and Disease: Past Patterns, Uncertain Futures* (Cambridge: Cambridge University Press, 2001).

[16] Hassan, Scholes and Ash (eds.), *Millennium Ecosystem Assessment, Volume 1*, p.520; James T. Carlton, 'Marine Bioinvasions: The Alteration of Marine Ecosystems by Nonindigenous Species,' *Oceanography* 9:1 (1996), pp.36-43; A.N. Cohen and J.T. Carlton, *Nonindigenous Aquatic Species in a United States Estuary: A Case Study of the Biological Invasions of the San Francisco Bay and Delta* (Washington DC: United States Fish and Wildlife Service Report, 1995).See also: Daniel Simberloff

However, among the greatest impacts on coastal ecosystems worldwide has been the transformation of bays and natural harbours into seaports. The ready availability of stone, gravel and sand on beaches, and exposed cliff faces, made coastlines important sites for the mining and quarrying of construction materials. And landmaking (or land claim) by draining marshlands and filling-in mudflats to create wharves to accommodate ships, warehouses to store goods, and other harbour infrastructure, has long been a widespread activity, as well as the construction of seawalls and other coastal defences to protect vessels and valuable waterfront property from waves, winds and storms.[17] However, the elimination of wetlands – which act like 'natural sponges' – can make 'waterproofed' cities more vulnerable to flooding, as well as destroying important coastal habitats.[18] To date, the environmental history of harbour engineering is under-researched, and only a few studies have paid close attention to the relationship between the development of port cities and coastal ecosystems. As Michael Rawson recently put it, most historians have tended to treat these cities 'as if they stop at the water's edge … they have not dived deep enough' to explore submerged harbour landscapes of channels, currents, seagrass and shifting sands.[19]

In his innovative study of the making of Boston harbour, Rawson not only charts the development of a major port city, he also looks beneath the surface of the water to examine the environmental impacts of building wharves, docks and granite seawalls, and of the dredging operations that kept open the deep shipping channels that enabled goods to flow. To safeguard the complex hydraulic system that supported Boston's engagement in an expanding global economy, from the late 1830s 'harbour lines' were drawn, regulated and controlled to prevent indiscriminate development that might hamper navigation and access for shipping; 'harbour lines' which determined the shape of the city's coastline. However, the engineering achievements that had 'improved' the connections between land and sea, to make the harbour more amenable for trade, had unforeseen and unwanted consequences. For example, they disrupted the ebb and flow of the tides that many contemporaries (mistakenly) believed were of crucial importance in preventing shoaling and silting, leading to more costly dredging operations, and causing anxiety about Boston's future as a leading port city by the mid-nineteenth century.[20]

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and Marcel Rejmánek (eds.) *Encyclopedia of Biological Invasions* (Berkeley and Los Angeles: University of California Press, 2011).

[17] Peter Borsay and John K. Walton (eds.), *Resorts and Ports: European Seaside Towns since 1700* (Bristol: Channel View Publications, 2011), introduction; Penna and Wright (eds.), *Remaking Boston*, chapters 2 and 3; Matthew Klingle, 'Changing Spaces: Nature, Property, and Power in Seattle, 1880-1945,' *Journal of Urban History* 32:2 (2006) pp.197-230; and *idem*, *Emerald City*, chapter 2.

[18] Hassan, Scholes and Ash (eds.), *Millennium Ecosystem Assessment, Volume 1*, chapter 19.

[19] Michael Rawson, 'What Lies Beneath: Science, Nature, and the Making of Boston Harbor,' *Journal of Urban History* 35:5 (2009) pp.675-97 (quote p.676).

[20] *Ibid*. See also, Rawson, *Eden on the Charles*, chapter 4. For a broader perspective, see: Adrian Jarvis (ed.) *Port and Harbour Engineering* (Aldershot: Ashgate, 1998); Nicholas C. Kraus (ed.) *History and Heritage of Coastal Engineering* (New York: American Society of Civil Engineers, 1996); Gordon Jackson, *The History and Archaeology of Ports* (Tadworth: World's Work, 1983); and Josef W.

The coastline is a naturally dynamic – not a static – place, and it constantly changes in response to winds, waves and tides. Building cities in coastal environments that are less stable than those inland; investing labour, engineering skill and enormous sums of money in landmaking and port development, not only in Boston but other places of trade and commerce, has also meant the costly maintenance and continuous upgrading of defences to protect them from the sea. In recent years, London, Rotterdam and Tokyo have all built expensive flood barriers which can be closed when a storm surge threatens. Venice, one of the longest-surviving European merchant cities, and a city with centuries of experience in dealing with sea level rise, is currently constructing its own flood barriers. Despite being designed as artificial sloping beaches, to mimic the action of natural flood defences, the Venetian MOSE barrier project has been widely criticised for the damaging environmental effects it may have on the lagoon's ecosystems, including impeding its tidal flushing action and threatening large areas of habitat for fish and water birds. In addition, it is likely that water shut out from the Venetian lagoon during a storm surge will overflow on less-protected areas of the Adriatic coast. Nevertheless, there is still considerable faith in, and reliance on, hard-engineered systems to protect coastal cities and subdue the sea.[21]

**Industry and Metabolism**

Up until the nineteenth century, even as global trade intensified, societies that were still mainly agrarian in character could only support a small number of big cities. Merchant cities such as Venice, London and Amsterdam still relied heavily on the natural resources of surrounding hinterlands for their survival. Amsterdam, for example, the leading centre of the world economy in the seventeenth and eighteenth centuries, had only between 200,000 and 250,000 residents during its so-called 'Golden Age'. But its success as the 'warehouse of the world' did see the Netherlands become the world's first nation with more than 10 per cent of its population living in urban centres. In 1800 there were just two cities in the world that had over a million inhabitants, London and Beijing, by 1950 there were 75, and in 2010 there were almost 450 (including 21 megacities of over 10 million inhabitants).[22]

It was the Industrial Revolution, characterised by Victorian Manchester as the 'workshop of the world', that removed constraints on the growth of cities. Although not a coastal city – Manchester was some 36 miles from the sea – it became Britain's fourth biggest port after the completion in 1894 of the Manchester Ship Canal (constructed so American cotton and other imported goods could bypass its

Konvitz, *Cities and the Sea: Port City Planning in Early Modern Europe* (Baltimore: Johns Hopkins University Press, 1978).

[21] For a recent discussion of the MOSE project from a pro-barrier perspective see: Dominic Standish, *Venice in Environmental Peril? Myth and Reality* (Lanham MD: University Press of America, 2012).

[22] Robert B. Marks, *The Origins of the Modern World: A Global and Ecological Narrative* (Lanham MD: Rowman & Littlefield, 2002); Oscar Gelderblom (ed.), *The Political Economy of the Dutch Republic* (Farnham: Ashgate, 2009); UN-HABITAT, *Cities and Climate Change*.

rival city of Liverpool and arrive directly at the industrialist's door).[23] And work by Roger Scola on Manchester's food supply (one of the first studies of its kind on a major city), and by Ian Douglas, Rob Hodgson and Nigel Lawson on Manchester's accelerating urban metabolism, has highlighted the way that changing consumption demands in the city were increasingly linked to an ever-widening supply area. The advent of the railways, and the construction of the Manchester Ship Canal, speeded the flow of both food and fibre into the city, and by the turn of the twentieth century supplies were coming in greater quantities from as far afield as Australasia, Asia, Africa, as well as the Americas. Refrigerated meat, for example, was arriving from New Zealand, Australia and Argentina. In addition, Chinese and Indian tea sweetened with Caribbean sugar fortified the factory operatives of 'Cottonopolis' to work long hours. By the turn of the nineteenth century, Manchester was no longer capable of feeding its own fast-growing population. And by the early twentieth century, the ecological impacts of Manchester's escalating demands for food and fibre extended far beyond its immediate hinterland.[24]

Despite Joel Tarr's recent call, and some stimulating conceptual work on urban centres as places of flows by scholars such as Sabine Barles, Matthew Gandy and Maria Kaika, to date only a handful of comprehensive metabolism studies have been produced on major cities around the world, including Cape Town, Hong Kong, London, Sydney and Tokyo (mainly undertaken by urban ecologists). Perhaps unsurprisingly, comparison of data from these studies show upwards trends in resource inputs overall – food, energy, construction materials and fresh water – as well as waste outputs since the 1950s.[25] Cities have also become increasingly independent of their local and regional environments for obtaining food, fuel and other material resources. As early as 1913, for example, British agricultural imports into London already travelled an average of 9,463 kilometres from farm to fork.[26]

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[23] Stephen Mosley, *The Chimney of the World: A History of Smoke Pollution in Victorian and Edwardian Manchester* (London & New York: Routledge, 2008); Ian Harford, *Manchester and its Ship Canal Movement* (Newcastle-under-Lyme: Keele University Press, 1994).

[24] Roger Scola, *Feeding the Victorian City: The Food Supply of Manchester, 1770-1870* (Manchester: Manchester University Press, 1992); Ian Douglas, Rob Hodgson and Nigel Lawson, 'Industry, Environment and Health through 200 Years in Manchester,' *Ecological Economics* 41:2 (2002) pp.235-55.

[25] Tarr, 'Metabolism of the Industrial City'; Sabine Barles 'A Metabolic Approach to the City: Nineteenth and Twentieth Century Paris,' in Dieter Schott, Bill Luckin and Genevieve Massard-Guilbaud (eds.) *Resources of the City: Contributions to an Environmental History of Modern Europe* (Aldershot: Ashgate, 2005); Matthew Gandy, 'Rethinking Urban Metabolism: Water, Space and the Modern City,' *City* 8:3 (2004) pp.363-79; Maria Kaika, *City of Flows: Modernity, Nature and the City*, (London & New York: Routledge, 2005). For a recent analysis of urban metabolism studies, see: Christopher Kennedy, John Cuddihy and Joshua Engel-Yan, 'The Changing Metabolism of Cities,' *Journal of Industrial Ecology* 11:2 (2007) pp.43-59.

[26] Michael Chisholm, 'The Increasing Separation of Production and Consumption' in B.L. Turner II *et al* (eds.), *The Earth as Transformed by Human Action* (Cambridge: Cambridge University Press, 1990) pp.88-89.

Their immediate hinterlands, however, were (and still are) widely used as sinks for disposing of wastes.

The seas have long been used as natural waste disposal systems, and until recently the prevailing view was that the oceans were an unlimited sink that could easily dilute and disperse harmful substances. Industry was attracted to coastal cities not only by easy access to market and transportation networks, but also because hazardous wastes could be discharged quickly, cheaply and directly into the sea. Large-scale industrial development since the late-eighteenth century has had profound impacts on coastal environments, particularly in Britain – the first industrial nation – where estuaries such as the Clyde, Forth, Mersey and Severn have all been heavily polluted.[27]

Diving deep, work done on the Bristol Channel and Severn Estuary by Peter French, for example, using core samples from mudflats and salt marsh sediments, reconstructs the depositional history of heavy metals and other contaminants in the area from the pre-industrial period to the present. Surrounded by copper works in Swansea and the South Wales steelworks and coalfields, as well as the more recent development of the oil and gas industries at Milford Haven (now one of the largest energy ports in Europe), sediment analysis in the Severn Estuary has shown rising levels of arsenic, copper, lead, PCBs, hydrocarbon compounds and other harmful elements since the advent of the Industrial Revolution, with very high concentrations found in and around ports and harbours.[28] There are three nuclear power plants in the area too, at Berkley, Oldbury and Hinckley Point, although routine monitoring suggests that levels of contamination in the marine environment are generally low. Nonetheless, biodiversity in the Severn Estuary as a whole is also low: heavy metals, for example, can impair the reproductive processes of marine organisms. And the pollutants which are stored in sediments, a problem in industrialised estuaries worldwide, can be slowly released when they are disturbed by strong tidal currents and dredging (and clean-up operations are complex and expensive). Pollution problems in the Severn Estuary were brought sharply into focus by the 1996 Sea Empress oil spill outside Milford Haven, when around 72,000 tonnes of crude oil were released, damaging more than 100 kilometres of the South Wales coastline and adversely affecting fisheries and wildlife, particularly seabirds.[29]

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[27] For a recent discussion, see: T.C. Smout, 'Garrett Hardin, The Tragedy of the Commons and the Firth of Forth,' *Environment and History* 17:3 (2011) pp.357-78. See also: Peter W. French, *Coastal and Estuarine Management* (London & New York: Routledge, 1997), chapter 4.

[28] Peter W. French, 'Post-Industrial Pollution Levels in Contemporary Severn Estuary Intertidal Sediments, Compared to Pre-Industrial Levels,' *Marine Pollution Bulletin* 26:1 (1993) pp.30-35; *idem*, 'Implications of a Saltmarsh Chronology for the Severn Estuary Based on Independent Lines of Dating Evidence,' *Marine Geology* 135 (1996) pp.115-25; Ronald Rees, *King Copper: South Wales and the Copper Trade, 1584-1895* (Cardiff: University of Wales Press, 2000); W.J. Langston et al, *Characterisation of European Marine Sites: The Severn Estuary* (Plymouth: Marine Biological Association, 2003).

[29] *Ibid.;* SEEEC, *The Environmental Impacts of the Sea Empress Oil Spill: Final Report of the Sea Empress Environmental Evaluation Committee* (London: The Stationary Office, 1998).

The Bristol Channel and other coastal waters have long been used for the direct disposal of human wastes too. Despite some leading figures in the influential British sanitary movement, particularly Sir Edwin Chadwick, arguing that the valuable nutrients in 'nightsoil' should be recycled, by the 1880s the Local Government Board had approved of all coastal towns and cities discharging their sewage directly into the sea. As late as the 1990s, 42 per cent of Britain's coastal sewage was still being discharged untreated.[30] In developed countries it is estimated that around $200 billion a year is needed to replace and upgrade aging and inadequate sewage systems, many now more than a century old, to protect water quality. And fast-growing coastal cities in most developing nations today still lack adequate sanitation and sewage treatment facilities. Every day billions of gallons of wastewater (often untreated) are discharged from outfall pipes along the coastlines of the world. In addition, a variety of pollutants from non-point sources also enter coastal waters, such as motor oil from run-off on roads, excess fertilisers from farms in river discharges, and even birth control hormones. The result is a complex mix of contaminants – both organic and inorganic – that can cause significant alterations in coastal ecosystems; from stimulating 'algal blooms', to the death and disease of marine plants and animals.[31]

## Seaside resorts and the coastal environment

Access to clean water was important to the development of the seaside resort, which had its eighteenth-century roots in sea-bathing as a treatment for various kinds of illness. By the nineteenth century, however, they were also becoming places of leisure and recreation for the masses. The railways were carrying millions of visitors every year to places such as Blackpool, the world's first working class seaside resort. It had around 2 million holiday visitors a year by the 1890s, mainly from Lancashire's 'cotton towns'. Seaports and coastal resorts often grew side-by-side, and they faced similar environmental problems. For example, the large seasonal influx of holidaymakers overloaded sewage systems. As water quality declined and became unhealthy, in 1923 Blackpool constructed an open air pool next to the sea that could accommodate some 1,500 swimmers, a common strategy employed by other resorts to 'improve' their seafront facilities. The need to protect hotels and attractions, as well as the beach itself, against the sea meant that there was little money available to spend on tackling coastal pollution in early resort areas (the cheap option of extending sewage outfalls further offshore was the one usually taken). By the 1930s, Blackpool had one of the highest per capita expenditures in

[30] John Hassan, *The Seaside, Health and the Environment in England and Wales since 1800* (Aldershot: Ashgate, 2003), p.44 and p.229.
[31] The Worldwatch Institute, *State of the World: Innovations for a Sustainable Economy* (New York & London: W.W. Norton, 2008), p.110; UN-HABITAT, *State of the World's Cities 2006/7*, pp.74-91; Klingle, *Emerald City*, p.261; Hassan, Scholes and Ash (eds.), *Millennium Ecosystem Assessment, Volume 1*, chapter 19.

Britain on sea defences.[32] As well as sea walls, to protect sandy beaches from erosion by the waves Blackpool and other resorts on the Fylde coast began to construct groynes, cross-shore structures designed to trap sand that also disrupt sediment flows. They cause the knock-on effect of starving beaches and dune systems further down the coastline of sediments, and accelerate the rate at which cliffs in these areas erode. To remain attractive to tourists, many beaches also had to be regularly 'renourished' with imported sand.[33] Dependable sunshine was also becoming a key element for pleasure seekers, who were often left disappointed by poor summer weather in northern European resorts like Blackpool.

Sunshine was the vital ingredient in the new package holiday industry which took off in the 1960s with the advent of cheap air travel. John Walton has recently charted the expansion of international seaside tourism, an industry now worth billions of dollars, and its social and environmental impacts on 'coastline after coastline', including: conflicts over access to and enjoyment of beaches; the decline of traditional industrial activities such as fishing as 'incompatible' with resort development; the deterioration of environments on both sides of the shoreline due to sewage, garbage and other forms of pollution; and the loss of landscape values.[34] Much of the scenic beauty of the Mediterranean coast has been lost due to overdevelopment, with the Spanish Costas providing the model for cheap 'sun, sea and sand' beach holidays which was reproduced around the globe. More than 100 million tourists currently visit the Mediterranean coast every year, and this number is expected to double by 2025. To maintain their attractive sandy beaches, many Spanish resorts import sand from the Sahara and other sources; most notably in the Canary Islands where visitors prefer golden sand to the local black volcanic variety. And in Spain fresh water, one of the major resource flows through towns and cities, began to be extracted at unsustainable levels due to growing tourist pressure. The water demands in coastal towns and cities for drinking and bathing, as well as for nearby golf courses, also restricted the availability of water resources for irrigated agriculture in the surrounding countryside, especially during the summer months when rainfall is low. Making an important contribution to Spanish and other economies, most tourist development took place with little consideration for the environment, and climate change is likely to further limit water availability in arid and semi-arid coastal areas.[35]

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[32] J.K. Walton, *Blackpool* (Edinburgh: Edinburgh University Press, 1998); Hassan, *The Seaside, Health and the Environment*, pp.111-12 and pp.127-28.

[33] French, *Coastal and Estuarine Management*, pp.77-78. For an innovative historical account of such issues in an Australian setting, see: Mike Danner, 'Reconciling Foreshore Development and Dune Erosion on Three Queensland Beaches: An Historical Perspective,' *Environment and History* 11:4 (2005) pp.447-74.

[34] John K. Walton, 'Seaside Tourism and Environmental History,' in Geneviève Massard-Guilbaud and Stephen Mosley (eds.), *Common Ground: Integrating the Social and Environmental in History* (Newcastle: Cambridge Scholars Publishing, 2011).

[35] Damià Barceló, Mira Petrovic and Jaume Alemany, 'Problems and Needs of Sustainable Water Management in the Mediterranean Area: Conclusions and Recommendations,' in Damià Barceló and Mira Petrovic (eds.), *Waste Water Treatment and Reuse in the Mediterranean Region* (Berlin

Ports and resorts, however, are not mutually exclusive categories, as Connie Chiang has recently shown in her study of the City of Monterey in California. The fishing and tourism industries existed side-by-side in Monterey from the second half of the nineteenth-century until the dramatic crash of the sardine fishery after the Second World War. Chiang explores the tensions between the two industries; between labour and leisure. For example, how the pungent smells that emanated from the processing plants that turned fish into cans of food and sacks of fertiliser produced numerous complaints from both hotel owners and holidaymakers. She also looks at the late-twentieth century regeneration of Cannery Row, made famous by John Steinbeck's classic novel, as a heritage attraction that now houses the world-renowned Monterey Bay Aquarium (in what was formerly the last working fish-processing plant in the city).[36] Collapsing fisheries, and the process of deindustrialisation in the developed world, left many other coastal cities with abandoned factories and warehouses, and since the 1980s they too have often been transformed into museums, shops, hotels, restaurants, offices and apartments. For example, in Europe Barcelona and London's Docklands, Melbourne Docklands in Australia, and in the United States Baltimore and Boston, are models of waterfront development. The redevelopment of waterfronts as places dedicated to leisure, consumption and the service industries, together with rising environmental awareness on the part of the public, has also resulted in multi-million dollar programmes being launched to improve water quality (sewage now is treated, but the technologies remain basically the same). The city of Boston, now a major financial centre with a vibrant waterfront, recently constructed one of the world's biggest undersea sewage outfalls 9.5 miles from the shoreline to remove offensive wastes from its harbour area.[37]

## Coastal Cities and Natural Disasters

The increasing incidence of so-called 'natural disasters' in urban areas, with coastal cities particularly vulnerable, has begun to focus historical attention on hazards such as floods, hurricanes, and earthquakes and their impacts. The history of disasters demonstrates that cities and their inhabitants are not somehow separate from the natural world. In addition, recent studies have revealed that 'natural disasters' are not entirely natural, as social structures and human actions – such as the construction of cheap housing on low-lying floodplains – put the poor in harm's

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Heidelberg: Springer-Verlag, 2011); R.J. Buswell, *Mallorca and Tourism: History, Economy and Environment* (Bristol: Channel View Publications, 2011); Allen Perry, 'Impacts of Climate Change on Tourism in the Mediterranean,' in Carlo Giupponi and Mordechai Shechter (eds.) *Climate Change in the Mediterranean* (Cheltenham: Edward Elgar, 2003); Erik Swyngedouw, 'Modernity and Hybridity: Nature, *Regeneracionismo*, and the Production of the Spanish Waterscape, 1890-1930' *Annals of the Association of American Geographers* 89:3 (1999) pp.443-65.

[36] Chiang, *Shaping the Shoreline*. See also: Borsay and Walton (eds.), *Resorts and Ports*.

[37] Lisa Benton-Short and John Rennie Short, *Cities and Nature* (London & New York: Routledge, 2008), pp.79-81; Kim Dovey, *Fluid City: Transforming Melbourne's Urban Waterfront* (Sydney: University of New South Wales Press, 2005); Patrick Malone (ed.), *City, Capital and Water* (London & New York: Routledge, 1995); Massachusetts Water Resources Authority, 'How Deer Island Treatment Plant Works,' http://www.mwra.state.ma.us/03sewer/html/sewditp.htm (accessed on 08.03.2012).

way.[38] Rapid urban and industrial development has also led to the decline of wetlands, mangrove forests, coral reefs, sand dunes and other habitats that in the past provided coastal areas with significant 'natural protection' against storms and flooding, by dissipating wave energy and absorbing flood waters. In addition, many coastal cities are vulnerable to seismic activity and tsunamis, and in his influential study of disasters in America Ted Steinberg noted that buildings constructed on 'made ground', such as land created by filling-in unstable wetlands, were more likely to collapse when earthquakes struck.[39]

Seismic building codes were one way to improve safety for city dwellers, and Gregory Clancey has recently examined the evolution of Japanese architecture and engineering in his book *Earthquake Nation*. Japan is located in the Pacific-Rim Seismic Zone, and most of its major cities are sited along the coast (some on land claimed from the sea). It suffers, on average, a major earthquake once every ten years. Clancey argues that while the Great Nōbi Earthquake of 1891 was not the most destructive in the nation's history, with a death toll of between 7,000 to 8,000 people over an area stretching from Tokyo to Osaka, it was one of the most important. Before the 1891 earthquake struck, the Meiji government of the day had been self-consciously Western in its outlook. Its modernisation project had seen the hiring of foreign architects and engineers - particularly from Britain - to transform Japan's 'fragile' wooden built environment into something more solid using bricks and mortar. But during the Great Nōbi Earthquake nearly all Western-style brick buildings collapsed, while new communications infrastructure such as railroad bridges was also destroyed. Transferred without much thought being given to local conditions, European design and materials were shown to be fragile and unsuited to the seismic Japanese environment. In contrast, the survival of seventeenth-century Nagoya Castle and other monumental Tokugawa-period buildings revealed the efficacy of traditional Japanese design in resisting seismicity (although the poorly constructed wooden homes of many ordinary people collapsed).[40]

After the catastrophe there was a revival of interest in – and a new appreciation for – traditional Japanese architecture, as well as some harsh criticism of over-Westernisation. The government was forced to re-evaluate a project that was clearly unsuited to an earthquake zone. As foreign knowledge had been found wanting, post-disaster there developed a hybrid building style better adapted to Japanese

[38] Ted Steinberg, 'The Secret History of Natural Disaster,' *Global Environmental Change Part B: Environmental Hazards* 3:1 (2001) pp.31-35. For recent surveys see: Uwe Lübken and Christof Mauch, 'Uncertain Environments: Risk and Insurance in Historical Perspective,' *Environment and History* 17:1 (2011) pp.1-13; Christof Mauch and Christian Pfister (eds.) *Natural Disasters, Cultural Responses: Case Studies toward a Global Environmental History* (Lanham MD: Lexington Books, 2009), introduction.

[39] Hassan, Scholes and Ash (eds.), *Millennium Ecosystem Assessment, Volume 1*, chapter 19; Ted Steinberg, *Acts of God: The Unnatural History of Natural Disaster in America* (New York: Oxford University Press, 2000), p.28 and p.44.

[40] Gregory Clancey, *Earthquake Nation: The Cultural Politics of Japanese Seismicity, 1868-1930* (Berkeley and Los Angeles: University of California Press, 2006); and *idem*, 'The Meiji Earthquake: Nature, Nation and the Ambiguities of Catastrophe,' *Modern Asian Studies* 40:4 (2006) pp.909-51.

conditions, and less dependent on the ideas of foreign 'experts', that synthesised the best of past and present design techniques.[41] Today Japan is widely regarded as an international role model in terms of its disaster preparedness. The nation's long experience in dealing with seismic shocks, its engineering prowess and its now rigorous building codes provided a measure of protection during the Sendai Earthquake in March 2011. Japan's great buildings did not fall, undoubtedly saving many thousands of lives in urban areas.

However, its sea defences, which stretch along nearly 40 percent of its coastline, were no match for the tsunami that followed. The 40-year-old Fukushima Daiichi nuclear plant, sited on the coast like many other nuclear power plants worldwide (because they require a plentiful supply of cooling-water), was not constructed to withstand a huge 'once in a thousand year' tsunami, resulting in a nuclear accident second only to Chernobyl. Even the depth of experience acquired by Japan as an 'earthquake nation' was insufficient to prepare for the cascading effects of multiple disasters – earthquake, tsunami and a nuclear crisis – causing at least 19,000 deaths.[42] The Fukushima accident damaged public confidence in nuclear power and led governments around the globe to reconsider the safety of nuclear plants. But even when decommissioned, those located on the coast will still need to be protected, at great expense, from sea level rise, flooding and erosion for hundreds of years after they have finished generating power.[43]

In the developing world, where less money is available to engineer solutions to natural disasters, resilience has to be built into communities instead. Greg Bankoff has examined how the poor of the Philippines, who live in one of the most disaster prone countries in the world, have a long history of forming self-help networks and organisations to cope with natural hazards that are 'simply a fact of life', building up a culture of community resilience.[44] This grassroots approach to disaster preparedness led, for example, to the establishment of the Citizen's Disaster Response Center in Manila in 1984. Drawing on local environmental knowledge, it offers disaster preparedness training programmes to vulnerable communities as well as emergency relief in disaster situations, and it has since expanded into a countrywide network of affiliated centres. In Havana, Cuba, a city that has to deal with frequent hurricanes, a similar culture of resilience has developed over time among its poor residents. For example, when Hurricane Wilma struck in October 2005 some 640,000 Cubans were safely evacuated from its path, with 'ordinary people' playing important roles in the

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[41] *Ibid.*

[42] See: http://www.world-nuclear.org/info/safety-and-security/safety-of-plants/fukushima-accident/ (accessed on 21.06.2014).

[43] 'Nuclear Power "Gets Little Support Worldwide,"' *BBC News* http://www.bbc.co.uk/news/science-environment-15864806 (accessed on 21.06.2014). A recent government report shows that as many as 12 out of 19 of Britain's civil nuclear sites are at risk of flooding by the 2080s, including Hinckley Point. See: 'UK Nuclear Sites at Risk of Flooding, Report Shows,' *Guardian* 07.03.2012.

[44] Greg Bankoff, *Cultures of Disaster: Society and Natural Hazard in the Philippines* (London & New York: Routledge, 2003); *idem*, 'Dangers to Going It Alone: Social Capital and the Origins of Community Resilience in the Philippines,' *Continuity and Change* 22:2 (2007) pp.327-55.

operation. Havana was seriously flooded, but no-one was killed or injured. Such a shift from disaster response to disaster preparedness has not yet occurred in many coastal cities – it was absent in New Orleans during Hurricane Katrina – and such examples offer useful models for the future.[45]

## Conclusion

To conclude, coastal cities are complex places, and they are still central to the global economy. Their study is a major challenge for historians, as evidence is not only found in the archives, we must also 'dive deeper' to examine submerged landscapes and the sediments of the harbour floor. As this paper has shown, their study covers so many topics no one model or approach will suffice. The concept of metabolism, however, is a good starting point for understanding resource flows into cities, and it also provides common ground for collaboration between scholars from different disciplines. The design and construction of infrastructures for water, sanitation, energy and transportation has also had a major impact on how resources flowed through cities – as well as on coastal ecosystems – revealing the interconnections between the built and the natural world. And as cities continue to expand in the coastal regions of the developing world, how they configure their infrastructures will play a major role in urban sustainability and resilience for the future.[46] Exploring the urban environmental problems of the past provides an invaluable context for reflecting on those of the present.

Given their importance as drivers of global environmental change, coastal cities deserve far more attention from historians. In terms of suggestions for further inquiry, building on some of the pioneering studies discussed above, the following themes and issues spring readily to mind:

- The need to better understand the interrelationships between cities and coastal ecosystems over time: they should be seen as a coherent whole.
- How has resilience been built into both coastal cities and coastal communities faced with frequent natural hazards?
- How has the design of 'hard engineered' infrastructure in coastal cities, which has generally taken little account of the ever-changing natural environment, contributed to problems such as pollution, erosion, silting and flooding?

[45] UN-HABITAT, *State of the World's Cities 2008/9: Harmonious Cities* (London: Earthscan, 2008), p.154; Senate Committee on Homeland Security and Government Affairs, *Hurricane Katrina: A Nation Still Unprepared* (Washington DC: Government Printing Office, 2006); Craig E. Colten, *Perilous Place, Powerful Storms: Hurricane Protection in Coastal Louisiana* (Jackson MS: University Press of Mississippi, 2009).

[46] UN-HABITAT, *Cities and Climate Change*; Gordon McGranahan, Deborah Balk and Bridget Anderson, 'The Rising Tide: Assessing the Risks of Climate Change and Human Settlements in Low Elevation Coastal Regions,' *Environment and Urbanization* 19:1 (2007) pp.17-37; Peter Timmerman and Rodney White, 'Megahydropolis: Coastal Cities in the Context of Global Environmental Change,' *Global Environmental Change* 7:3 (1997) pp.205-34.

- Legislative and policy responses to changing environmental conditions: why has effective governance of coastal zones proved so difficult?
- The social and cultural dimensions: for example, who gained and who lost as port-resort relationships changed?
- In the face of such complexity, there is also a need to encourage closer cooperation across disciplines, between urban historians and natural scientists, along the lines of the recent 'The Sea and the Cities' project for the Baltic region coordinated by Simo Laakkonen.[47]

And finally, to paraphrase Michael Rawson, coastal cities are perhaps the best places to study the interactions between society and nature.[48]

[47] 'The Sea and the Cities': http://www.valt.helsinki.fi/projects/enviro/ (accessed on 21.06.2014).
[48] Rawson, 'What Lies Beneath', p.676.